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Integrated Computer Control System Countdown Status Messages Simulation

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Lawrence Livermore National Laboratory

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FY98 LDRD Project

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1 Introduction

1.1 Background

The Integrated Computer Control System (ICCS) CORBA-Based Simulation LDRD wa guide the design of the complex ICCS framework in its application to the Na (NIF) and thereby reduce performance risks. A simulation study was perform Milestone to "Develop Shot Cycle Workflow Simulation." Status messages fr shot countdown activities were included in a discrete event simulation to as on commercial components and their utilization in current designs.

1.2 Objective

The purpose of the study was to use simulation to help validate the design messages during countdown will not overload the network; i.e., that the com sized to handle the expected traffic.

1.3 Scope

The scope of the present study was to layout the framework for the Status M Simulation (SMCS) using the discrete event simulation package, SIMPROCESS, t inputs for running the model, and to obtain estimates of resource utilizati becomes available, inputs can be updated to include additional refinements, SIMPROCESS has a "Design of Experiments" capability which can be used to eva scaling ICCS component utilization and resource allocation on system behavi not been implemented at this time.

2 Design Description

2.1 Countdown Activities

Figure 2-1 shows the activities during a typical NIF countdown. The figure to scale, with the 'countdown' arrow representing five minutes. The four a engineers to include as part of the SMCS are 1) plasma electrode Pockels ce 2) wavefront control, 3) preamplifier module (PAM) charging, and 4) main am Status messages will arise from each of these activities as they monitor th the status on to the supervisory console for that system. The rate and si each of the application's front-end processors (FEP) and on to the supervis obtained by interviews with experts and from NIF interface control document description and latencies were obtained from network designers and were scal represent the network interfaces for each of the four countdown activities activities and from the network latencies relevant to the simulation will b sections.

2.1.1 *PEPC Conditioning Status Messages*

There are three PEPC FEPs for each NIF cluster of 48 laser beamlines. They (PM) FEP, 2) a plasma pulser / gas and vacuum (PPGV) FEP, and 3) a switch pu povide a table describing the worst case scenario for PEPC device monitorin FEPs to the supervisory system during the five minute pre-shot countdown (t and 2-2 show the peak operation message traffic from the PM and PPGV FEPs, no message traffic from the SP FEP during countdown. The PEPC FEPs travel FEP through a 10 Mb/s fiber; and from the 10/100 Mb/s ethernet switch throu

line to the core ethernet and out to the supervisory consoles. Figure 2-2
the ethernet connections from client to server FEP. Details of the PEPC F
the first ethernet switch are shown in Figure 2-3. The packet size and byte
2-2 will provide inputs to the simulation.

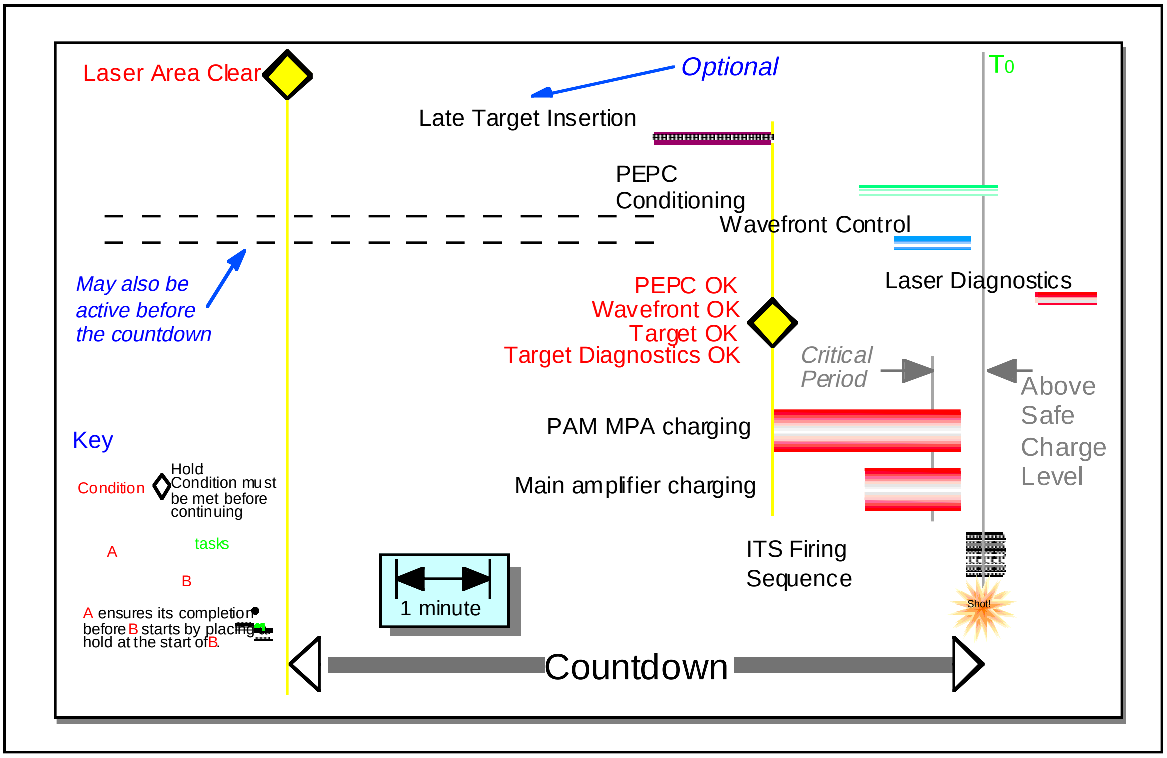


Figure 2-1. ICCS activities during countdown.

Table 2-1. Peak operation message traffic from PEPC PM FEP during countdow

PEPC FEP	Device	Device Count	Signals	Signal / Device	Total Signals	Rate (Hz)	Msg / sec	Bytes / Msg	Bytes / sec
PM Solaris	plasma current	4	plasma current	1	4	0.2	1	16,000	16,000
PM Solaris	switch voltage	8	switch voltage	1	8	0.2	1	32,000	32,000
Total							2		48,000

Table 2-2. Peak operation message traffic from PEPC PPGV FEP during countc

PEPC FEP	Device	Device Count	Signals	Signal / Device	Total Signals	Rate (Hz)	Msg / sec	Bytes / Msg	Bytes / sec
PPGV vxworks	simmer	48	current & voltage	2	96	0.2	1	48,000	48,000
PPGV vxworks	PEPC pressure	24	gas & vacuum pressure	2	48	1			
PPGV vxworks	PEPC gauges	84	pressure	1	84	1	1	528	528
Total							2		48,528

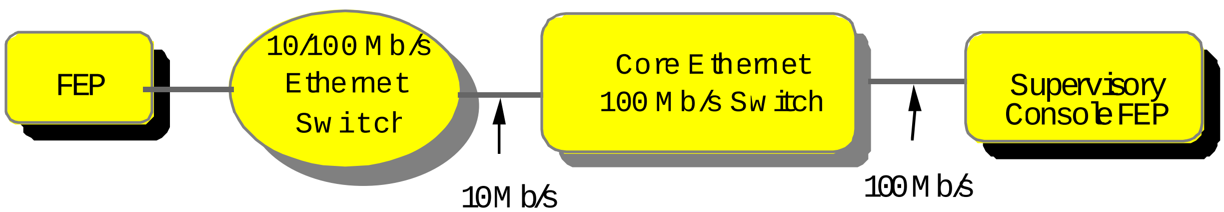


Figure 2-2. Typical client FEP to server FEP ethernet.

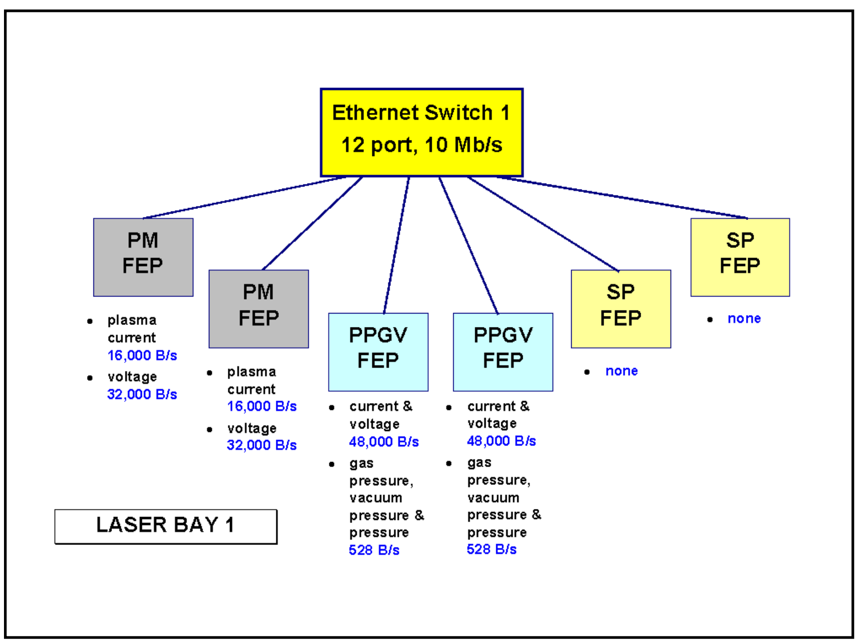


Figure 2-3. PEPC Ethernet system diagram.

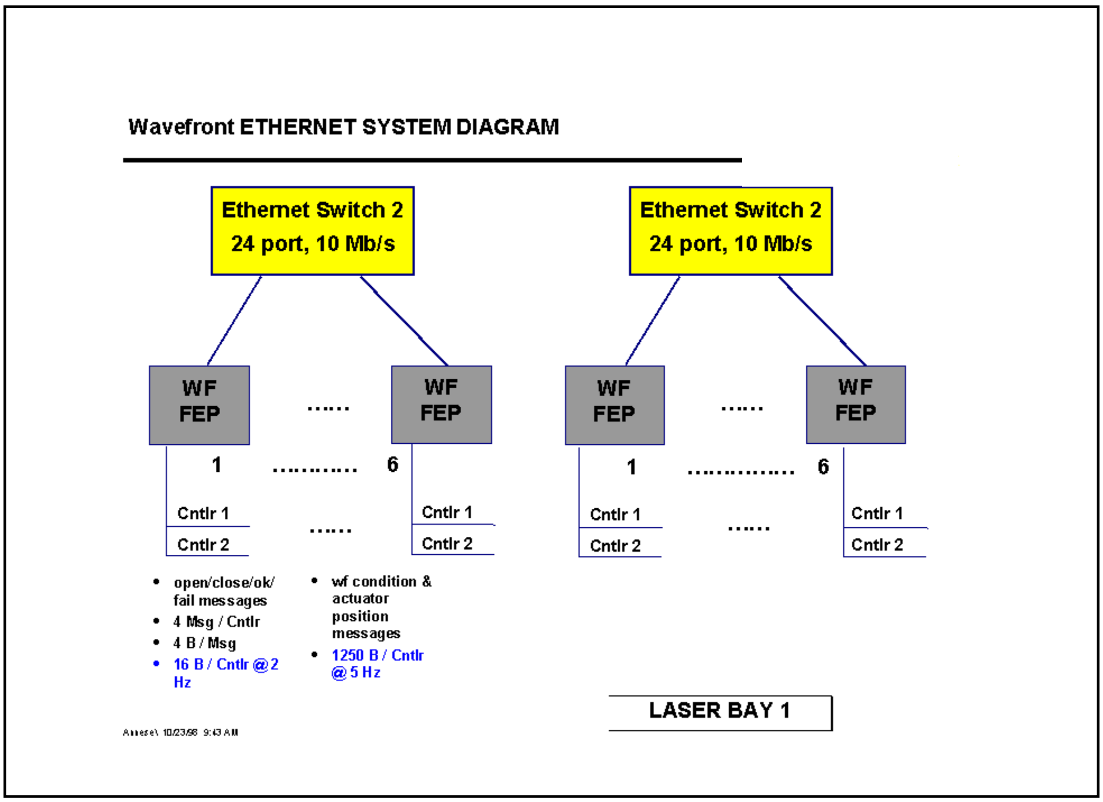
2.1.2 *Wavefront Control Status Messages*

Wavefront control status messages during countdown were obtained from conve system designer. Figure 2-4 illustrates the size and types of messages usec

2.1.3 *PAM MPA Charging Status Messages*

There are 48 PAM FEPs. Status message size and delivery rates were obtaine with design engineers. There is one voltage status message for each PAM FEI is 4 Bytes long and is generated at once per second. Though there are four countdown of Figure 2-1 that appear to coincide with the start of the PAM (wavefront OK, target OK, and target diagnostics OK, the start of the PAM cl on receiving any of these OK signals; the charging starts two minutes prior summarizes this status message from the PAM for easy reference. As for the messages travel from the application FEP through a 10 Mb/s fiber; and from switch through a 100 Mb/s ethernet line to the core ethernet and out to th

The packet size and bytes/sec from Table 2-3 will provide inputs to the sim the PAM Ethernet layout used in the simulation.



Fgure 2 4.   Wavefront message size and types used in the countdown simulati

Table 2-3. Peak operation message traffic from PAM FEP during five minute

PAM FEP	Device	Device Count	Signals	Signal / Device	Total Signals	Rate (Hz)	Msg / sec	Bytes / Msg	Bytes / sec
	charging	48	voltage	1	48	1	1	4 * 48 = 192	192

2.1.4 *Main Amplifier Charging Status Messages*

Figure 2-6 shows the main amplifier power conditioning ethernet system diag
simulation. The main capacitors will start charging at ~77 seconds prior to
ionization lamp check (PILC) capacitors will start charging at ~31 seconds
status message during countdown, therefore, will consist of a floating poin
voltage starting at 77 seconds prior to shot, at half second intervals; the
concurrent with a second floating point value for PILC capacitor voltage st
to shot, also at half second intervals. The timing system will wait for per
PILC modules before going into the final two seconds of countdown.

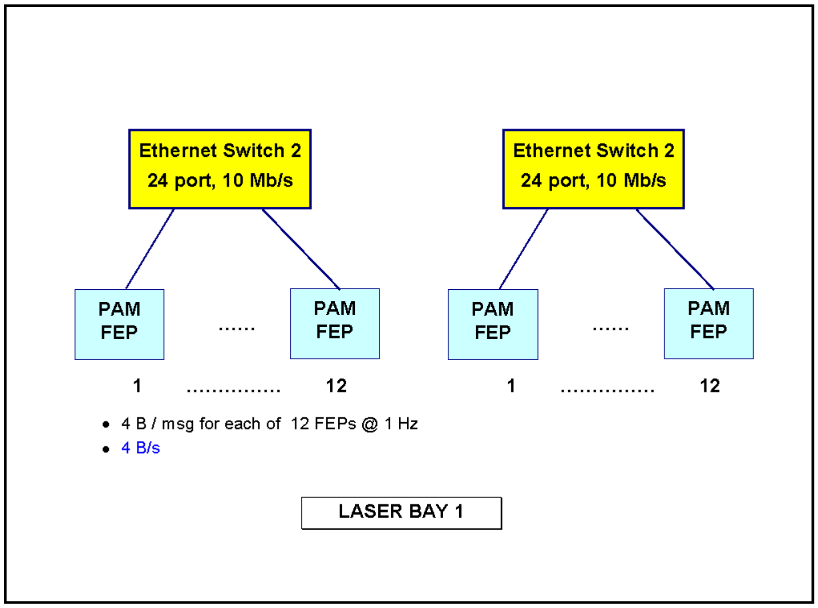


Figure 2-5. PAM Ethernet system diagram.

2.2 Transaction Time Measurements

2.2.1 *FEP and Network Description*

Experimental latency times for the FEPs were derived from measurements incl
application takes to interface with CORBA, with the transmission control p
protocol (TCP/IP) protocol, and the network interface card driver. Figure
configuration used for the measurements. Table 2-4 shows an example of the
various portions of the ICCS network from application FEPs, through Etherne
ethernet switch, and on to the supervisory FEP. These times were measured
connects a typical FEP client through Ethernet to a supervisory server. An
bits, often expressed 6 hexadecimal 8-bit words separated by columns. The
sent is ~ 1500 bytes.

2.2.2 *Message Overheads*

Message sizes are increased by overhead added from CORBA, TCP, and IP. The
describe the size and types of information added to the message packets.

TCP Protocol[1]

TCP provides timely and ordered data delivery, connection establishment, da
termination, and full duplex. It adds around 20 bytes to the original mess
packet switching mode, which means that data is separated into smaller pack
sequence numbers, does not necessarily arrive at the destination in the same
at the destination in the proper order according to the sequence numbers.
flow control and error checking, urgent ("out-of-band" data, data stream pu
and reporting service failures). Ports 1 - 1023 are reserved for applicati
1024 to above can be used as long as no one else is using them. TCP lets y
successful. There are 16 bits for port numbers, so there are 64,000 ports a
maximum packet size that can be sent prior to waiting for an acknowledgment
TCP packet format is as shown in Table 2-5.

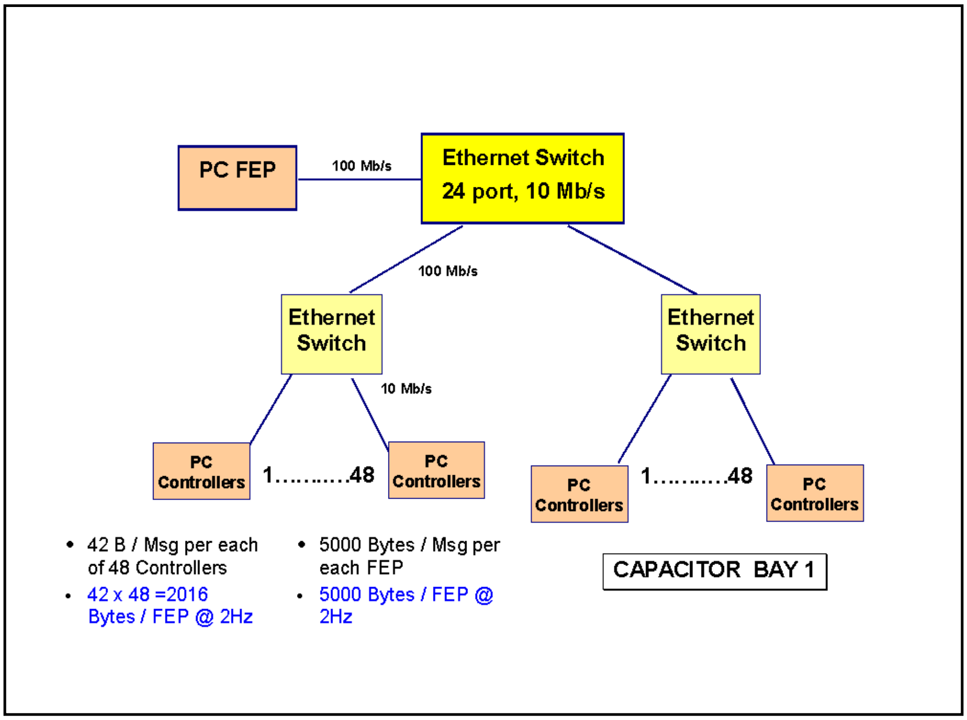


Figure 2-6. Main amplifier power conditioning Ethernet system diagram.

[1] Eugene Pinsky, Massachusetts Institute of Technology, TCP/IP Networking course notes from Boston University via satellite to LLNL, LTV 1366, 5/98, p. 4-6.

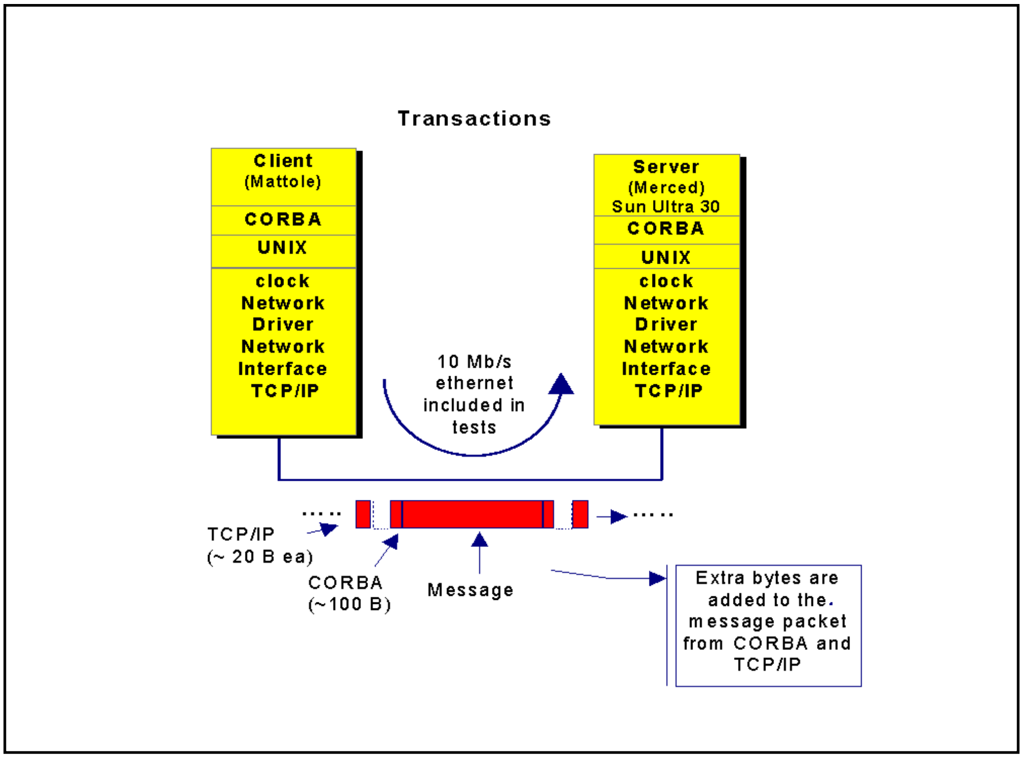


Figure 2-7. Measurements were made of transaction times between Sun Ultrasp
10 Mb/s ethernet in-between.

IP Protocol [1]

Internet Protocol makes "best effort" delivery, utilizes fragmentation and
mechanism for end-to-end reliability, flow control or sequencing. Thus it
provide the added functions and reliability. See Table 2-6 for details. T
protocol identifier, such as TCP, UDP (user datagram protocol), or ICMP, fo
datagram contains 32-bit IP addresses. IP adds 20 bytes in length to each
addition to the 20+ bytes added by TCP. Common object-request broker archit
protocol adds about 100 bytes of data to each message.

CORBA

Corba adds about 100 bytes of data to[2] each message.

[2] Conversation with Eric Stout, LLNL.

Table 2-4. Transactions per second from Mattole to Merced through 10Mb/s

Message Size (FPA)	Byte Size FPA * 4	Client Process Time (msec) / CPU Utilization		Server Process Time (msec)		Client Null CPU Utilization	Server Null CPU Utilizati	Clock Time
2	8	.545	.44	.452	.37	.48	.25	1.233
4	16	.545	.44	.473	.38	.47	.26	1.229
8	32	.545	.43	.462	.37	.47	.28	1.254
16	64	.548	.43	.388	.30	.48	.29	1.284
32	128	.552	.41	.443	.33	.47	.28	1.346
64	256	.548	.38	.281	.19	.47	.31	1.457
128	512	.554	.33	.412	.24	.47	.29	1.700
256	1024	.566	.26	.544	.25	.46	.30	2.195
512	2,048	.634	.20	.643	.20	.47	.28	3.152
1,024	4,096	.733	.14	.932	.18	.48	.28	5.096
2,048	8,192	.917	.10	1.301	.15	.47	.31	8.934
4,096	16,384	1.128	.07	2.223	.13	.46	.31	17.060
8,192	32,768	1.600	.05	3.701	.11	.47	.30	32.758
16,384	65,536	2.583	.04	7.098	.10	.48	.26	68.134
32,768	131,072	4.578	.03	14.912	.11	.46	.31	132.143
65,536	262,144	8.769	.03	29.224	.11	.47	.30	260.339
131,072	524,288	17.384	.03	63.220	.11	.46	.30	516.352

Table 2-5. TCP adds at least 20 bytes in length (assumes 8 bits/byte) to e

0 4 8 12 16 20 24 28 32 (bits)

SOURCE PORT (APPLICATION)			DESTINATION PORT (APPLICATION)	TCP HEADER
SEQUENCE NUMBER				
ACKNOWLEDGEMENT NUMBER				
DATA OFFSET	RESERVE D	CONTROL (ACK FLAG)	WINDOW (FLOW CONTROL)	
CHECKSUM			URGENT CALL POINTER	
OPTIONS			PADDING	
DATA				

2.2.3 *Experimental Measurements of Latencies*

Assessment of the transactions times in Table 2-4 led to the creation of f and supervisor FEP latencies, and 10 Mb/s Ethernet latencies. An overhead transaction is attributed that leads to the following three formulations in

Client FEP Latency = .000342 * Bytes + .54
Server FEP Latency = .00011 * Bytes + .430
10 Mb/s Ethernet Latency = .00087 * Bytes + .215

The ratio of the formulation to the actual data is shown in Figures 2-8, 2 for client FEP, server FEP, and 10 Mb/s Ethernet latencies.

Table 2-6. IP adds at least 20 bytes in length (assumes 8 bits/byte) to ea

0 4 8 12 16 2 24 28 32 (bits)

VERSION	HDR LENGT H	SERVICE TYPE	TOTAL LENGTH		IP HEADER
IDENTIFICATION			FLAGS	OPERATION	
TIME TO LIVE		PROTOCOL	HEADER CHECKSUM		
SOURCE INTERNET ADDRESS					
OPTIONS			PADDING		
DATA					

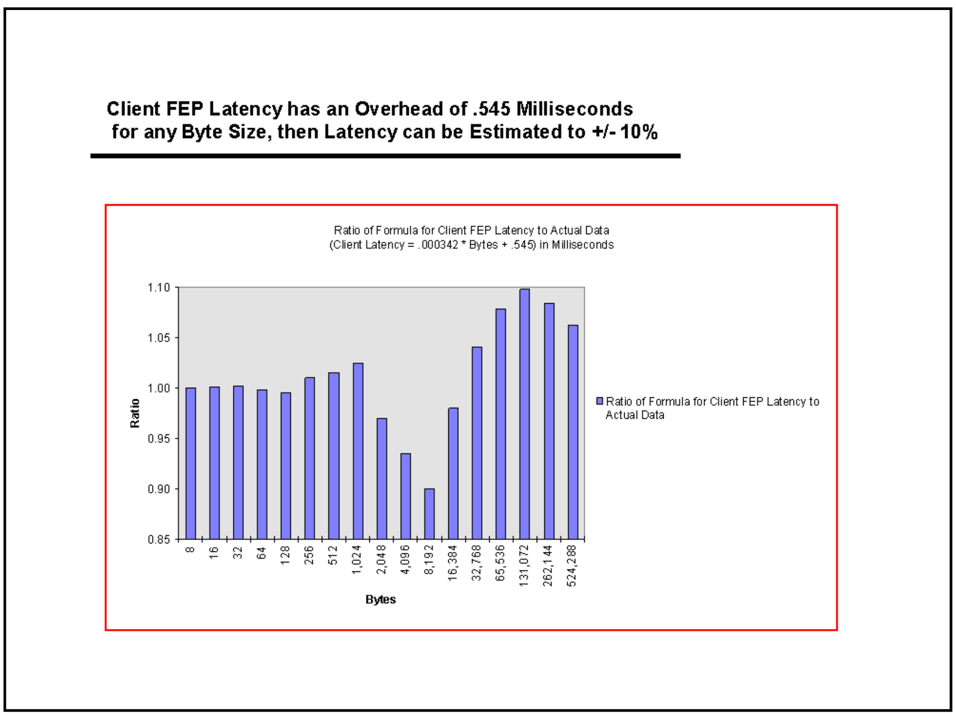


Figure 2-8. Client FEP latency can be estimated to +/- 10%.

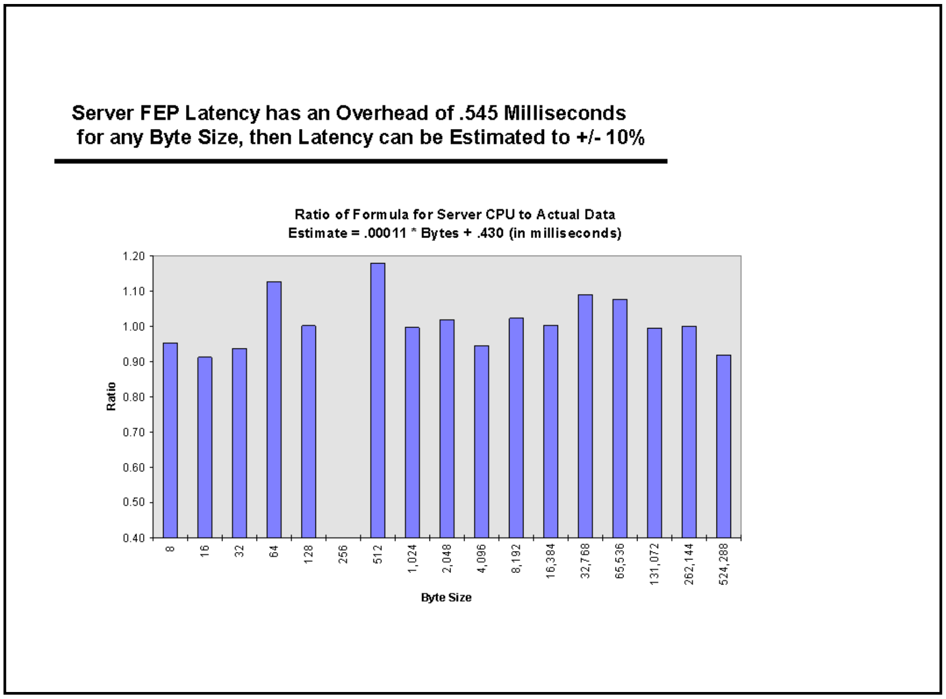


Figure 2-9. Server FEP latency can be estimated to +/- 10%.

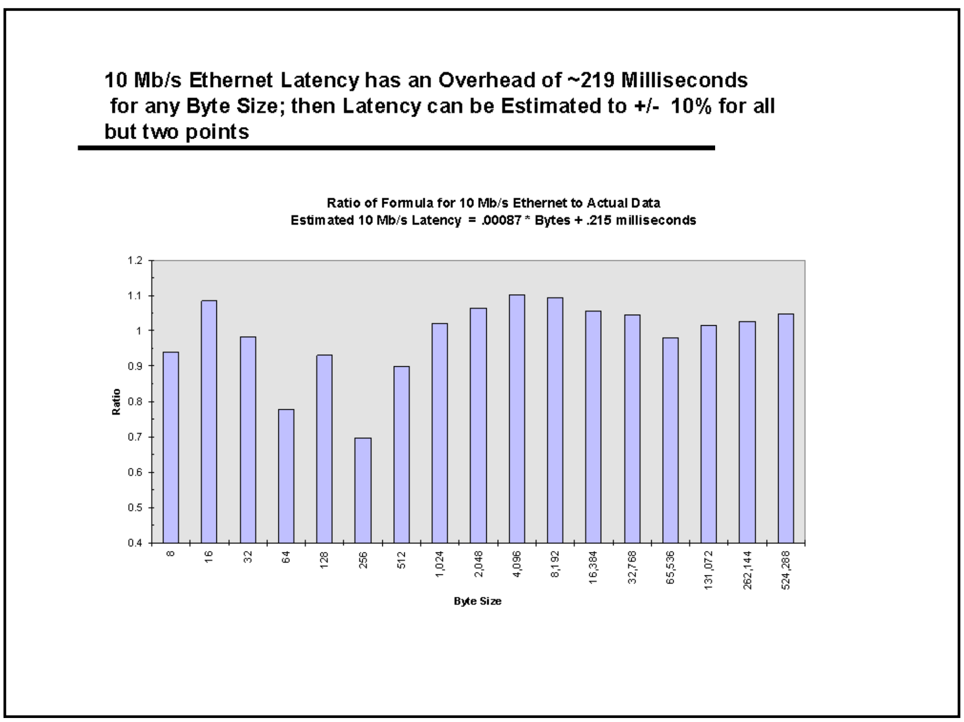


Figure 2-10. 10 Mb/s ethernet latency can be estimated to +/- 10% for all

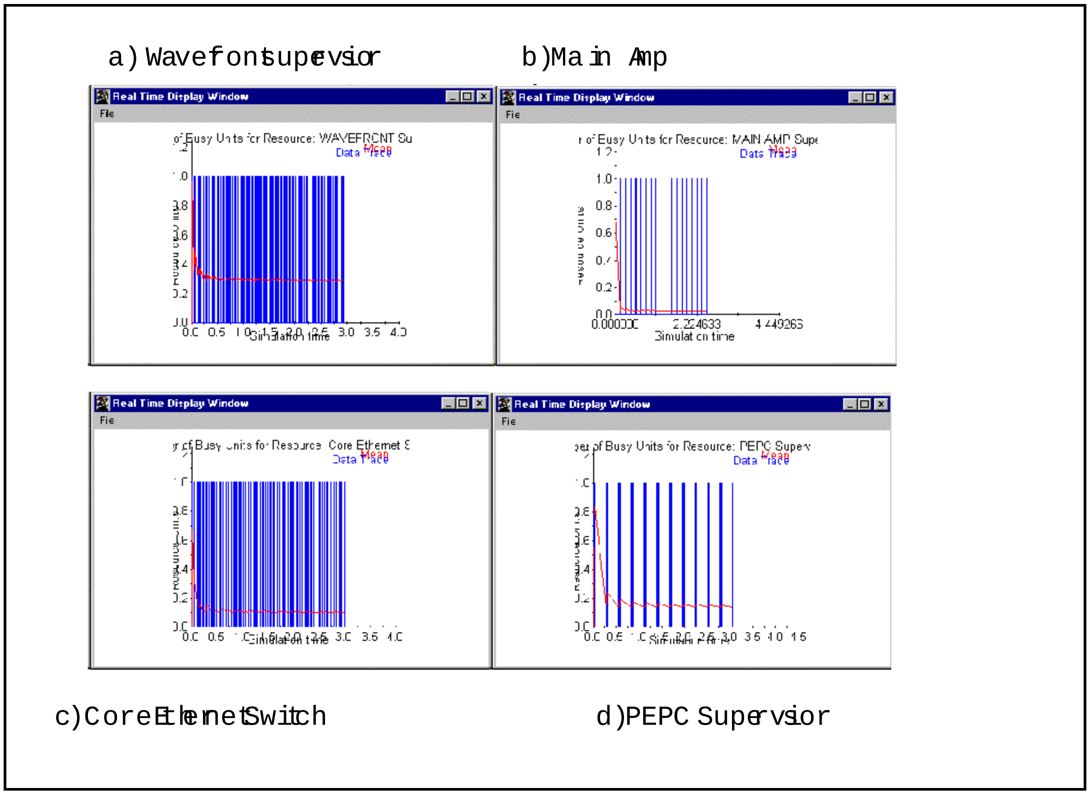


Figure 2-11. Average percent resources busy during busiest time of five-min[3]

The resource utilization vs simulation time is plotted in Figure 2-11 for e status messages. The x-axis represents simulation time in hours;[4] however, had shown that Simprocess did not work well using fractions of seconds as in represented as 1 second, and a second was represented as 1000 seconds. So, 0.28 hours on the graph, represents one second in the model.

The time that resources spent waiting for resources was also tallied and va milliseconds for the main amp power conditioning signals to around 80 millis current and voltage signals.

3 Discussion

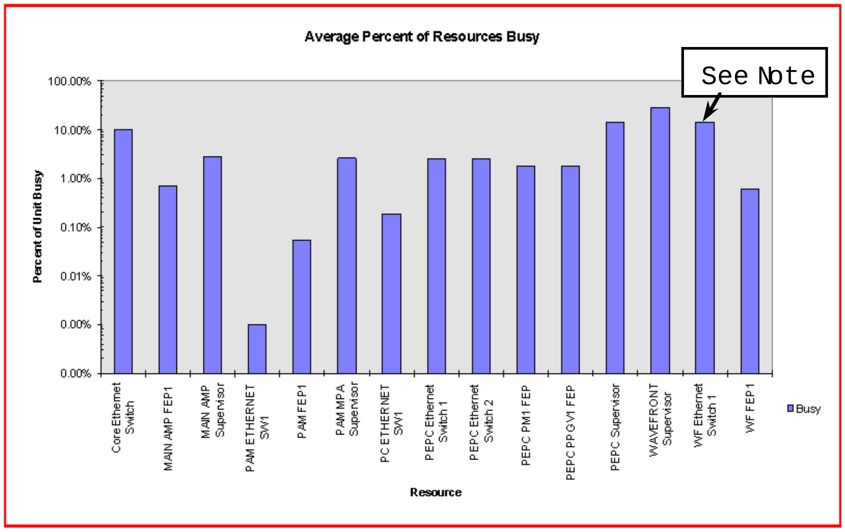
To conservatively assess the demand on the system, the Simprocess model was represents the period when all messages occur simultaneously. Data was col average percent of resources busy. These vary from less than 0.001% for tl to over 20% for the wavefront supervisor. They are shown in Figure 3-1.

4 Conclusions

The Simprocess status message simulation provides a good visual tool for unc network utilization. Supervisory displays and their latencies will vie for included in the model when they become available. While point estimates ha

[3] Bar for wavefront Ethernet switch 1 also includes 10 Mb/s Ethernet plus the switch.
[4] Conversation with B. Kettering who ran Status Monitor simulation with Simprocess and discovered that Simprocess did not work well using fractions of seconds as inputs to the model.

work, statistical distributions can easily be used in their place and a des:
will allow variation of parameters for optimization when loads start to look heavy.



NOTE: The WF Ethernet Switch 1 bar represents 10Mb/s ethernet as well as switch

Figure 3-1. Resource utilization vs simulation time for four resources.